PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-280155
(43)Date of publication of application : 10.10.2001

(51)Int.Cl. F02C 7/22
F02C 7/26
F23R 3/26
F23R 3/28
F23R 3/30

(21)Application number : 2000-094902
(22)Date of filing : 30.03.2000

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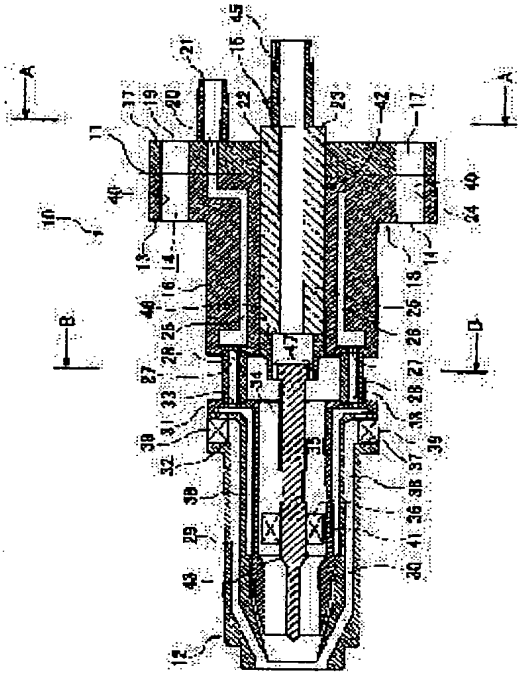
(54) FUEL INJECTION METHOD AND DEVICE FOR GAS TURBINE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a fuel injection device capable of supplying atomized fuel having few flow amount and high pressure even in ignition and low load regions of a gas turbine.
SOLUTION: In the ignition and low load region, high pressure adding air is led from a port 45. Adding air passes an inner space 35, and liquid fuel having few flow rate is atomized. Feeding of adding air is stopped in association with increase of engine rotating speed, and a normal operation is carried out.



LEGAL STATUS

[Date of request for examination] 07.02.2005
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]
[Date of registration]
[Number of appeal against examiner's decision

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CLAIMS

[Claim(s)]
[Claim 1] Make it circle around the predetermined direction of fuel injection, and liquid fuel is formed in the shape of a thin film annulus ring. It is the fuel-injection approach for gas turbines which atomizes the liquid fuel concerned and carries out injection supply in the combustion chamber of a gas turbine by supplying the combustion air which made it circle around the above-mentioned fuel-injection direction to the inside and the outside of a fuel which were formed in the shape of [concerned] a thin film annulus ring. The fuel-injection approach for gas turbines characterized by feeding the addition air which joins the combustion air supplied to the above-mentioned inside only at the time of start up of a gas turbine.
[Claim 2] the fuel-injection approach for gas turbines according to claim 1 -- setting -- the pressure of the above-mentioned addition air -- 0.2MPa-0.5MPa it is -- the fuel-injection approach for gas turbines characterized by things.
[Claim 3] Make it circle around the predetermined direction of fuel injection, and liquid fuel is formed in the shape of a thin film annulus ring. It is the fuel injection equipment for gas turbines which atomizes the liquid fuel concerned and carries out injection supply in the combustion chamber of a gas turbine by supplying the combustion air which made it circle around the above-mentioned fuel-injection direction to the inside and the outside of a fuel which were formed in the shape of [concerned] a thin film annulus ring. The fuel injection equipment for gas turbines characterized by having the addition air feeding means for feeding the addition air which joins the combustion air supplied to the above-mentioned inside.
[Claim 4] The fuel injection equipment for gas turbines characterized by having further an air turning means to make it circle in the combustion air to which the above-mentioned addition air is supplied by the above-mentioned inside, and this direction in the fuel injection equipment for gas turbines according to claim 3.
[Claim 5] It is the fuel injection equipment for gas turbines characterized by having the advice nozzle section which it shows to the combustion air by which addition air is supplied to the above-mentioned addition air feeding means by the above-mentioned inside in the fuel injection equipment for gas turbines according to claim 3 or 4.
[Claim 6] It is the fuel injection equipment for gas turbines characterized by projecting to the air-current side formed of the combustion air by which the above-mentioned advice nozzle section is supplied to the above-mentioned inside in the fuel injection equipment for gas turbines according to claim 5.
[Claim 7] It is the fuel injection equipment for gas turbines characterized by having the addition air guide bar which is formed in the point of the nozzle from which the above-mentioned advice nozzle section receives supply of addition air in the fuel injection equipment for gas turbines according to claim 6, and a nozzle, and is prolonged in the above-mentioned air-current direction.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The field of the technique in which invention belongs] This invention relates to amelioration of the fuel injection equipment used for a gas turbine.
[0002]
[Description of the Prior Art] In order to run continuously a gas turbine good in the whole region, while atomizing a fuel (atomization), it is necessary to secure the flow rate according to an operation region (load region), and to supply a combustion chamber. For this reason, the fuel injection equipment for supplying a fuel to a combustion chamber is variously offered from the former.
[0003] Generally as a fuel-injection method, there are a pressure spraying method (henceforth a "pressure method") and an air-current atomization method (henceforth a "air-current method"). A pressure method changes a fuel into a high voltage condition, and atomizes it by injecting this from a nozzle, and its range which can be fuel-flow adjusted is narrow. Moreover, an air-current method contacts high-speed air (air for atomization) to a fuel, and is atomized, and its range which can be fuel-flow adjusted is wide.
[0004] It is necessary to set a fuel as a very small flow rate at the time of start up of a gas turbine (firing - low revolution region). For this reason, it is desirable to carry out injection supply of the little fuel with a pressure method at the time of start up. On the other hand, it is necessary to supply the fuel (for a turndown ratio to be 1:20-40) of an amount according to each service condition in the time of operation (firing - full load region).
[0005] However, by the pressure method, fuel pressure needs to put a high pressure, in order to atomize and supply a fuel, covering a turndown ratio since it has a relation proportional to the square of a flow rate (the amount of fuel supply). For this reason, if it is going to secure a required fuel flow all over the districts, in a full load region, a fuel must be extremely made into high voltage, and it enlarges for reservation of a fuel injection equipment on the strength, and weight becomes heavy and is not practical, either.
[0006] For this reason, in the former, the thing of an air-current method is adopted in the no-load - full load region. That is, the conventional fuel injection equipment was constituted in many cases by putting side by side the nozzle of two types of the nozzle of a pressure method, and the nozzle of an air-current method.
[0007]
[Problem(s) to be Solved by the Invention] However, in this conventional fuel injection equipment, structure becomes complicated, and while weight increases, a manufacturing cost also rises.
[0008] Then, the 1st object of this invention is offering the fuel-injection approach for gas turbines only the air-current method which can attain the good atomization of a fuel being adopted even if an injection pressure's is generally low, and supply of a good fuel being secured in the whole region.
[0009] Moreover, the 2nd object of this invention is offering the cheap and lightweight fuel injection equipment for gas turbines for using the above-mentioned approach.
[0010]
[Means for Solving the Problem] (1) In order to attain the 1st object of this invention, invention concerning this application Make it circle around the predetermined direction of fuel injection, and

liquid fuel is formed in the shape of a thin film annulus ring. It is the fuel-injection approach for gas turbines which atomizes the liquid fuel concerned and carries out injection supply in the combustion chamber of a gas turbine by supplying the combustion air which made it circle around the above-mentioned fuel-injection direction to the inside and the outside of a fuel which were formed in the shape of [concerned] a thin film annulus ring. It is characterized by feeding the addition air which joins the combustion air supplied to the above-mentioned inside only at the time of start up of a gas turbine.

[0011] While according to this configuration supplying the liquid fuel of a few flow rate (for example, five cc/second - 20cc/(second)) at the time of no-load [of a gas turbine] (at the time of start up), making it circle in this along the direction of fuel supply and forming in the shape of a thin film annulus ring, the addition air of a required pressure (for example, 0.2MPa-0.5MPa) is fed with an addition air feeding means inside the fuel formed in the shape of [above-mentioned] a thin film annulus ring. The addition air of the required pressure concerned joins by this the combustion air by which inhalation of air was carried out by the compressor of a gas turbine, and a fuel is atomized under the above-mentioned pressure and sent to a combustion chamber.

[0012] If a gas turbine starts steady operation, since the liquid fuel which the inhalation of air of a lot of combustion air was carried out, and was formed in the shape of [above-mentioned] a thin film annulus ring by the compressor of a gas turbine will be atomized, the above-mentioned addition air feeding means is stopped, and feeding of addition air is stopped. In addition, since the combustion air by which inhalation of air was carried out by the compressor is supplied to the inside and the outside of a fuel which were formed in the shape of [above-mentioned] a thin film annulus ring, it can atomize a fuel good.

[0013] Especially, it is 0.2MPa-0.5MPa about the pressure of addition air. When using an industrial gas turbine by carrying out, the compressed air for air tools furnished to works etc. can be used as addition air.

[0014] (2) In order to attain the 2nd object of this invention, invention concerning this application Make it circle around the predetermined direction of fuel injection, and liquid fuel is formed in the shape of a thin film annulus ring. It is the fuel injection equipment for gas turbines which atomizes the liquid fuel concerned and carries out injection supply in the combustion chamber of a gas turbine by supplying the combustion air which made it circle around the above-mentioned fuel-injection direction to the inside and the outside of a fuel which were formed in the shape of [concerned] a thin film annulus ring. It is characterized by having the addition air feeding means for feeding the addition air which joins the combustion air supplied to the above-mentioned inside.

[0015] While according to this configuration first supplying the liquid fuel of a few flow rate (for example, five cc/second - 20cc/(second)) at the time of start up of a gas turbine, making it circle in this along the direction of fuel supply and forming in the shape of a thin film annulus ring, the addition air of a required pressure (for example, 0.2MPa-0.5MPa) is fed with an addition air feeding means inside the fuel formed in the shape of [above-mentioned] a thin film annulus ring. This joins the combustion air by which inhalation of air was carried out by the compressor of the addition air gas turbine of the required pressure concerned, and a fuel is atomized under the above-mentioned pressure and sent to a combustion chamber.

[0016] If a gas turbine starts steady operation, since the liquid fuel which the inhalation of air of a lot of combustion air was carried out, and was formed in the shape of [above-mentioned] a thin film annulus ring by the compressor of a gas turbine will be atomized, the above-mentioned addition air feeding means is stopped, and feeding of addition air is stopped. In addition, since the combustion air by which inhalation of air was carried out by the compressor is supplied to the inside and the outside of a fuel which were formed in the shape of [above-mentioned] a thin film annulus ring, it can atomize a fuel good.

[0017] Here, atomization of a fuel can be made much more good by establishing an air turning means to make it circle in the combustion air (suitably henceforth "inside air") supplied inside the fuel formed in the shape of [above-mentioned] an annulus ring, and this direction in the above-mentioned addition air.

[0018] Moreover, addition air can be made to certainly join the above-mentioned addition air feeding means in combustion air by preparing the advice nozzle section which shows addition air to the above-mentioned inside air. Furthermore, unification of addition air can be made into a more positive thing by

making this advice nozzle section project to the air-current side formed of the above-mentioned inside air.

[0019] Furthermore, addition air can be certainly led to inside air along with the guide bar by having and constituting the addition air guide bar formed in the point of the nozzle which receives supply of addition air, and a nozzle in the above-mentioned advice nozzle section. Thereby, unification to the combustion air of addition air can be made into a still more positive thing.

[0020]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained.

[0021] Drawing 1 is the appearance perspective view of the fuel injection equipment concerning 1 operation gestalt of this invention, and drawing 2 is the sectional view showing the internal structure of a fuel injection equipment.

[0022] The outline of a fuel injection equipment 10 is explained with reference to these drawings.

[0023] The fuel injection equipment 10 is equipped with a base 11 and the injection section 12, and the flange 13 is formed in the base 11. This fuel injection equipment 10 is installed in the combustion chamber of a gas turbine, and carries out injection supply of the fuel from the injection section 12 at a combustion chamber. Installation of a fuel injection equipment 10 is performed by fixing a flange 13 to the inlet-port periphery section of a combustion chamber while inserting the injection section 12 in the combustion chamber of a gas turbine. With this operation gestalt, conclusion immobilization of a flange 13 and the inlet-port periphery section of a combustion chamber is carried out by inserting a bolt in the conclusion bolt insertion hole 14, and binding this tight.

[0024] The place by which it is characterized [of this operation gestalt] is in the supply system of a fuel. That is, the point of sending the addition air of a predetermined pressure to a combustion chamber compulsorily at the time of gas turbine start up according to the addition air feeding device 15 (addition air feeding means) with which this fuel injection equipment 10 atomizes and supplies a fuel only with the so-called air-current method, and the base 11 was equipped is the point. Thereby, the good fuel supply corresponding to the operation whole region is possible from the time of start up of a gas turbine, and since only an air-current method is moreover adopted, structure of a fuel injection equipment 10 can be simplified, and a fuel injection equipment 10 can be cheaply offered now. Hereafter, it explains in detail.

[0025] (1) The base 11 is equipped with the body 16, the end plate 17, and the addition air feeding device 15. Drawing 3 is A-A cross-section view drawing in drawing 2 . It explains with reference to drawing 1 - drawing 3 .

[0026] The end plate 17 is attached in the back end side of a body 16. The end plate 17 is carrying out discoid, as shown in drawing 3 , and four breakthroughs 19 are formed in the radial on the basis of the core. This breakthrough 19 constitutes the conclusion bolt insertion hole 14 mentioned above. Moreover, the fuel-supply hole 20 is formed in eight radials on the basis of the core of an end plate 17. As each fuel-supply hole 20 penetrates an end plate 17, is formed and shows drawing 2 , the port 21 for connecting a fuel pipe (not shown) to each fuel-supply hole 20 protrudes. In addition, of course with this operation gestalt, it is not what is limited to this number in the above-mentioned breakthrough 19 although four and eight fuel-supply holes 20 were formed. Moreover, in the center of an end plate 17, penetration formation of the opening 22 centering on the core of an end plate 17 is carried out. The air advice pipe 23 of the addition air feeding device 15 which mentions this opening 22 later is inserted in.

[0027] With reference to drawing 2 , the body 16 is formed in the shape of a cylinder, and the flange 24 is formed in the back end section. This flange 24 constitutes the flange 13 mentioned above. Four breakthroughs 40 are formed in the flange 24. These breakthroughs 40 and the breakthrough 19 of the above-mentioned end plate 17 are set as the diameter of said, and its core of each hole corresponds. Therefore, the conclusion bolt insertion hole 14 mentioned above is constituted by the breakthrough prepared in the flange 24, and the above-mentioned breakthrough 19.

[0028] The breakthrough 25 is formed in the core of a body 16 along with the longitudinal direction of a body 16. This breakthrough 25 is set as opening 22 and the diameter of said of the above-mentioned end plate 17, it is in the condition which attached the end plate 17 in the body 16, and a breakthrough 25 and its opening 22 correspond exactly. And the supporter which supports the addition air feeding device 15 by this breakthrough 25 and opening 22 is constituted, and the addition air feeding device 15 is carried out like the after-mentioned, and is supported by the base 11.

[0029] Moreover, eight fuel advice holes 26 are formed in the back end side of a body 16 corresponding to the fuel-supply hole 20 of an end plate 17. That is, the fuel with which the fuel-supply hole 20 and the fuel advice hole 26 were in agreement exactly with the fuel, and were supplied to the port 21 where an end plate 17 is attached in a body 16 is guided in the interior of a body 16 to a head side. Each fuel advice hole 26 is penetrated to the apical surface of a body 16, and eight openings 27 corresponding to this are formed in the apical surface of a body 16. In addition, the pipe member 28 is being fixed to each opening 27, and the fuel guided at opening 27 is further guided through this pipe member 28 to the injection section 12 side.
[0030] (2) Next, the injection section 12 is formed in the shape of a cylinder as a whole, as shown in drawing 1 , and it is equipped with the outer case section 29 and the container liner section 30 (refer to drawing 2). Drawing 4 is a B-B sectional view in drawing 2 . It explains with reference to drawing 2 and drawing 4 .
[0031] The container liner section 30 is the member of the shape of a pipe by which the collar 31 was formed in the end face section. On the other hand, the outer case section 29 is also the member of the shape of a pipe by which the collar 32 was formed in the end face section. And the container liner section 30 is inserted from the end face section side of the outer case section 29, and the container liner section 30 is attached in the outer case section 29 in the condition of having made the collar 31 contacting a collar 32. Eight breakthroughs 33 are formed in the collar 31 of the container liner section 30. The above-mentioned pipe member 28 is connected to each breakthrough 33. Thereby, the fuel by which supply advice was carried out is further sent to the pipe member 28 to the injection section 12 side.
[0032] Opening 34 is formed in the center of the collar 31 of the container liner section 30, it is open for free passage to this opening 34, and the building envelope 35 is formed inside the container liner section 29. This opening 34 functions as intake of the combustion air of a fuel, and the adopted air is sent along a building envelope 35. And the swirler 36 (air turning means) is arranged in the building envelope 35 like the after-mentioned. Thus, the combustion air taken in by the building envelope 35 forms an air current.
[0033] The outer case section 29 is further formed in tubed [of dual structure]. If it explains in full detail further with reference to drawing 1 and drawing 2 , two or more inlet ports 37 are formed in the perimeter of a collar 32, and the inhalation-of-air way 38 is formed in it succeeding each inlet port 37. This inhalation-of-air way 38 is formed in tubed in the interior of the outer case section 29. The air by which the swirler 39 is formed in each inlet port 37, and inhalation of air is carried out from this inlet port 37 serves as a turning style which circles around the longitudinal direction of the outer case section 29 with a swirler 39, and this turning style flows along the above-mentioned inhalation-of-air way 38. In addition, the air adopted from each inhalation-of-air hole 37 is spent on combustion of a fuel like the air adopted from the above-mentioned opening 34 (that is, used as combustion air).
[0034] Where the container liner section 30 is inserted in the outer case section 29, as shown in drawing 2 , a clearance 41 is formed among both. This clearance 41 will be formed in a circle, and is open for free passage with each pipe member 28. Therefore, by the pipe member 28, the fuel by which supply advice was carried out advances into this clearance 41, and is sent to the head side of the injection section 12 through a clearance 41. Here, the head side of a clearance 41 is spirally formed in accordance with shaft orientations. By this, the fuel sent to the head side will circle to the circumference of the shaft orientations, and will be formed in the shape of a light-gage annulus ring.
[0035] Therefore, the above-mentioned combustion air is sent to the inside and the outside of a fuel which were formed in the shape of [above-mentioned] a thin film annulus ring.
[0036] (3) Next, explain the addition air feeding device 15 with reference to drawing 1 and drawing 2 .
[0037] The addition air feeding device 15 is equipped with a body 42 and the guide bar 43 (addition air guide bar).
[0038] The body 42 has the air advice pipe 23 mentioned above, the port 45 connected to the back end of the air advice pipe 23, and the nozzle 46 prepared at the head of the air advice pipe 23.
[0039] The air advice pipe 23 is inserted in in the hold space formed with the opening 22 of an end plate 17, and the penetration opening 25 of a body 16. Moreover, a port 45 is a part which adopts addition air from the outside, for example, the compressed air for air tools is supplied at works etc.
[0040] The nozzle 46 is formed in the shape of [by which the diameter of a head side was reduced / so-

called] a pipe with a stage, as shown in drawing 2 . The back end side of a nozzle 46 is exactly inserted into the above-mentioned hold space, and contact fixing of the back end side is carried out with the apical surface of the air advice pipe 23. Moreover, the point by which the diameter of a nozzle 46 was reduced projects to the air-current side formed of the above-mentioned combustion air sent to a building envelope 35 from the opening 34 side 34 of the container liner section 30 of the injection section 12, i.e., opening. Thus, about the operation effectiveness by the point of a nozzle 46 projecting, it mentions later.

[0041] Drawing 4 is B-B cross-section view drawing in drawing 2 . With reference to drawing 2 and drawing 4 , the guide bar 43 is formed by the thin bottom rod with a circular cross section. a collar with the circular back end section of the guide bar 43 -- it is formed in the ** and this part is exactly inserted in the head side of a nozzle 46. The guide bar 43 is inserted in the shape of the abbreviation same axle into the container liner section 30, and the point is prolonged to near the head of the injection section 12. Thereby, as the air in a building envelope 35 meets this guide bar 43, it is fed good.
[0042] As shown in drawing 4 , the hole 47 penetrated to shaft orientations is formed in the back end section of the guide bar 43. With this operation gestalt, the hole 47 should just be formed so that this four hole 47 may be formed, ********** may not be limited to this number and addition air can be sent to the above-mentioned building envelope 35 from a nozzle 46.
[0043] Moreover, the swirler 36 (air turning means) mentioned above to the pars intermedia of the guide bar 43 is formed. This swirler 36 is for making it circle the right or in the counterclockwise direction in the combustion air taken in from opening 34 around the longitudinal direction of the container liner section 30. With the combustion air taken in from opening 34, the addition air led to the building envelope 35 is depended swirler 36, circles, and is sent to a head side.
[0044] (4) Next, explain actuation of the fuel injection equipment 10 concerning this operation gestalt with the operation effectiveness.
[0045] With reference to drawing 1 and drawing 2 , a fuel (liquid fuel) is sent to the injection section 12 side through the pipe member 28 with this fuel injection equipment 10 through the fuel advice hole 26 from a port 21. The fuel sent to the injection section 12 side is formed in the shape of a thin film annulus ring through a clearance 41. While the air which air (combustion air) was adopted by a fuel and coincidence from an inlet port 37 and opening 34, and was adopted from the inlet port 37 on the other hand circles in the predetermined direction, the air adopted from opening 34 circles in the anti-predetermined direction. The combustion air which circles to an opposite direction mutually, respectively is sent to the inside and the outside of a fuel which were formed in the shape of a thin film annulus ring by this, and a fuel is atomized by both air current. That is, only an air-current method is used for the fuel injection equipment 10 concerning this operation gestalt.
[0046] By the way, the gas turbine for which this fuel injection equipment 10 is used needs to press down the fuel supplied at the time of no-load (at the time of start up) to small quantity (for example, five cc/second - 20cc/(second)). However, when supplying a fuel with an air-current method, a little fuel cannot be atomized good. It is because an engine rotational frequency is low and sufficient quantity of combustion air cannot be incorporated in the time of no-load - a low loading region.
[0047] However, with this operation gestalt, addition air can be introduced according to the addition air feeding device 15 in this firing - a low loading region. This addition air is introduced in the advice space 35 of the injection section 12 from a nozzle 46 through the air advice pipe 23 from a port 45. This addition air can use the compressed air for air tools, and is 0.2MPa-0.5MPa as that pressure. The thing of extent is employable.
[0048] This high-pressure addition air is fed inside the fuel formed in the shape of [above-mentioned] a thin film annulus ring through the building envelope 35. Thereby, high-pressure addition air joins the above-mentioned combustion air, and a fuel is atomized under the above-mentioned pressure and sent to a combustion chamber.
[0049] Then, if a gas turbine starts steady operation, since a lot of combustion air will be sent and a fuel will be atomized good by the compressor of a gas turbine, the addition air feeding device 15 is stopped and feeding of addition air is stopped. In addition, since the air sent by the compressor is supplied to the inside and the outside of a fuel which were formed in the shape of a thin film annulus ring as mentioned above, it can atomize a fuel good.
[0050] The swirler 36 is formed and it can be made to circle in the combustion air and this direction to

which the above-mentioned addition air is supplied inside the above-mentioned fuel with this operation gestalt especially. Thereby, there is an advantage that the vigor of the turning air current of the inside air concerned can make atomization of increase and a fuel much more good.

[0051] Moreover, since the nozzle 46 is formed in order to feed addition air, addition air can be made to certainly join combustion air. And since this nozzle 46 is made to project to an opening 34 side, addition air can be made to much more certainly join the air current formed in a building envelope 35. Thereby, atomization of a fuel can be made still much more good.

[0052] Thus, with this operation gestalt, since the method of feeding high-pressure addition air is adopted only at the time of start up of a gas turbine, the minute fuel of a pressure required at the time of start up can be atomized, and it can start certainly. And in the operation region after start up, a fuel can be supplied with the usual air-current method. Therefore, in the operation whole region of a gas turbine, while performing proper fuel supply only by the air-current method and being able to realize good continuous running, structure of a fuel injection equipment 10 can be simplified and it can consider as a cheap thing.

[0053]

[Effect of the Invention] According to invention which relates to this application as mentioned above, the following effectiveness is done so. At the time of start up of a gas turbine (at the time of ignition), since it is a no-load region, the fuel flow which should be supplied must be a minute amount. On the other hand, if the pressure of a supply fuel is low at the time of start up, it cannot start (ignition). However, in this invention, since the minute fuel of a pressure required for start up can be supplied by supplying addition air at the time of start up, it can start certainly. And in the operation region after start up, a fuel can be supplied with the usual air-current method by suspending supply of addition air.

[0054] Thus, in this invention, in the operation whole region of a gas turbine, since proper fuel supply by the air-current method is performed, good continuous running is not made possible and a pressure method like before and an air-current method moreover are not used together, structure can consider as an easy and cheap thing.

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TECHNICAL FIELD

[The field of the technique in which invention belongs] This invention relates to amelioration of the fuel injection equipment used for a gas turbine.
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PRIOR ART

[Description of the Prior Art] In order to run continuously a gas turbine good in the whole region, while atomizing a fuel (atomization), it is necessary to secure the flow rate according to an operation region (load region), and to supply a combustion chamber. For this reason, the fuel injection equipment for supplying a fuel to a combustion chamber is variously offered from the former.
[0003] Generally as a fuel-injection method, there are a pressure spraying method (henceforth a "pressure method") and an air-current atomization method (henceforth a "air-current method"). A pressure method changes a fuel into a high voltage condition, and atomizes it by injecting this from a nozzle, and its range which can be fuel-flow adjusted is narrow. Moreover, an air-current method contacts high-speed air (air for atomization) to a fuel, and is atomized, and its range which can be fuel-flow adjusted is wide.
[0004] It is necessary to set a fuel as a very small flow rate at the time of start up of a gas turbine (firing - low revolution region). For this reason, it is desirable to carry out injection supply of the little fuel with a pressure method at the time of start up. On the other hand, it is necessary to supply the fuel (for a turndown ratio to be 1:20-40) of an amount according to each service condition in the time of operation (firing - full load region).
[0005] However, by the pressure method, fuel pressure needs to put a high pressure, in order to atomize and supply a fuel, covering a turndown ratio since it has a relation proportional to the square of a flow rate (the amount of fuel supply). For this reason, if it is going to secure a required fuel flow all over the districts, in a full load region, a fuel must be extremely made into high voltage, and it enlarges for reservation of a fuel injection equipment on the strength, and weight becomes heavy and is not practical, either.
[0006] For this reason, in the former, the thing of an air-current method is adopted in the no-load - full load region. That is, the conventional fuel injection equipment was constituted in many cases by putting side by side the nozzle of two types of the nozzle of a pressure method, and the nozzle of an air-current method.

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EFFECT OF THE INVENTION

[Effect of the Invention] According to invention which relates to this application as mentioned above, the following effectiveness is done so. At the time of start up of a gas turbine (at the time of ignition), since it is a no-load region, the fuel flow which should be supplied must be a minute amount. On the other hand, if the pressure of a supply fuel is low at the time of start up, it cannot start (ignition). However, in this invention, since the minute fuel of a pressure required for start up can be supplied by supplying addition air at the time of start up, it can start certainly. And in the operation region after start up, a fuel can be supplied with the usual air-current method by suspending supply of addition air.
[0054] Thus, in this invention, in the operation whole region of a gas turbine, since proper fuel supply by the air-current method is performed, good continuous running is not made possible and a pressure method like before and an air-current method moreover are not used together, structure can consider as an easy and cheap thing.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in this conventional fuel injection equipment, structure becomes complicated, and while weight increases, a manufacturing cost also rises.
[0008] Then, the 1st object of this invention is offering the fuel-injection approach for gas turbines only the air-current method which can attain the good atomization of a fuel being adopted even if an injection pressure's is generally low, and supply of a good fuel being secured in the whole region.
[0009] Moreover, the 2nd object of this invention is offering the cheap and lightweight fuel injection equipment for gas turbines for using the above-mentioned approach.

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MEANS

[Means for Solving the Problem] (1) In order to attain the 1st object of this invention, invention concerning this application Make it circle around the predetermined direction of fuel injection, and liquid fuel is formed in the shape of a thin film annulus ring. It is the fuel-injection approach for gas turbines which atomizes the liquid fuel concerned and carries out injection supply in the combustion chamber of a gas turbine by supplying the combustion air which made it circle around the above-mentioned fuel-injection direction to the inside and the outside of a fuel which were formed in the shape of [concerned] a thin film annulus ring. It is characterized by feeding the addition air which joins the combustion air supplied to the above-mentioned inside only at the time of start up of a gas turbine.
[0011] While according to this configuration supplying the liquid fuel of a few flow rate (for example, five cc/second - 20cc/(second)) at the time of no-load [of a gas turbine] (at the time of start up), making it circle in this along the direction of fuel supply and forming in the shape of a thin film annulus ring, the addition air of a required pressure (for example, 0.2MPa-0.5MPa) is fed with an addition air feeding means inside the fuel formed in the shape of [above-mentioned] a thin film annulus ring. The addition air of the required pressure concerned joins by this the combustion air by which inhalation of air was carried out by the compressor of a gas turbine, and a fuel is atomized under the above-mentioned pressure and sent to a combustion chamber.
[0012] If a gas turbine starts steady operation, since the liquid fuel which the inhalation of air of a lot of combustion air was carried out, and was formed in the shape of [above-mentioned] a thin film annulus ring by the compressor of a gas turbine will be atomized, the above-mentioned addition air feeding means is stopped, and feeding of addition air is stopped. In addition, since the combustion air by which inhalation of air was carried out by the compressor is supplied to the inside and the outside of a fuel which were formed in the shape of [above-mentioned] a thin film annulus ring, it can atomize a fuel good.
[0013] Especially, it is 0.2MPa-0.5MPa about the pressure of addition air. When using an industrial gas turbine by carrying out, the compressed air for air tools furnished to works etc. can be used as addition air.
[0014] (2) In order to attain the 2nd object of this invention, invention concerning this application Make it circle around the predetermined direction of fuel injection, and liquid fuel is formed in the shape of a thin film annulus ring. It is the fuel injection equipment for gas turbines which atomizes the liquid fuel concerned and carries out injection supply in the combustion chamber of a gas turbine by supplying the combustion air which made it circle around the above-mentioned fuel-injection direction to the inside and the outside of a fuel which were formed in the shape of [concerned] a thin film annulus ring. It is characterized by having the addition air feeding means for feeding the addition air which joins the combustion air supplied to the above-mentioned inside.
[0015] While according to this configuration first supplying the liquid fuel of a few flow rate (for example, five cc/second - 20cc/(second)) at the time of start up of a gas turbine, making it circle in this along the direction of fuel supply and forming in the shape of a thin film annulus ring, the addition air of a required pressure (for example, 0.2MPa-0.5MPa) is fed with an addition air feeding means inside the fuel formed in the shape of [above-mentioned] a thin film annulus ring. This joins the combustion air by which inhalation of air was carried out by the compressor of the addition air gas turbine of the required pressure concerned, and a fuel is atomized under the above-mentioned pressure and sent to a

combustion chamber.
[0016] If a gas turbine starts steady operation, since the liquid fuel which the inhalation of air of a lot of combustion air was carried out, and was formed in the shape of [above-mentioned] a thin film annulus ring by the compressor of a gas turbine will be atomized, the above-mentioned addition air feeding means is stopped, and feeding of addition air is stopped. In addition, since the combustion air by which inhalation of air was carried out by the compressor is supplied to the inside and the outside of a fuel which were formed in the shape of [above-mentioned] a thin film annulus ring, it can atomize a fuel good.
[0017] Here, atomization of a fuel can be made much more good by establishing an air turning means to make it circle in the combustion air (suitably henceforth "inside air") supplied inside the fuel formed in the shape of [above-mentioned] an annulus ring, and this direction in the above-mentioned addition air.

[0018] Moreover, addition air can be made to certainly join the above-mentioned addition air feeding means in combustion air by preparing the advice nozzle section which shows addition air to the above-mentioned inside air. Furthermore, unification of addition air can be made into a more positive thing by making this advice nozzle section project to the air-current side formed of the above-mentioned inside air.
[0019] Furthermore, addition air can be certainly led to inside air along with the guide bar by having and constituting the addition air guide bar formed in the point of the nozzle which receives supply of addition air, and a nozzle in the above-mentioned advice nozzle section. Thereby, unification to the combustion air of addition air can be made into a still more positive thing.
[0020]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained.
[0021] Drawing 1 is the appearance perspective view of the fuel injection equipment concerning 1 operation gestalt of this invention, and drawing 2 is the sectional view showing the internal structure of a fuel injection equipment.
[0022] The outline of a fuel injection equipment 10 is explained with reference to these drawings.
[0023] The fuel injection equipment 10 is equipped with a base 11 and the injection section 12, and the flange 13 is formed in the base 11. This fuel injection equipment 10 is installed in the combustion chamber of a gas turbine, and carries out injection supply of the fuel from the injection section 12 at a combustion chamber. Installation of a fuel injection equipment 10 is performed by fixing a flange 13 to the inlet-port periphery section of a combustion chamber while inserting the injection section 12 in the combustion chamber of a gas turbine. With this operation gestalt, conclusion immobilization of a flange 13 and the inlet-port periphery section of a combustion chamber is carried out by inserting a bolt in the conclusion bolt insertion hole 14, and binding this tight.
[0024] The place by which it is characterized [of this operation gestalt] is in the supply system of a fuel. That is, this fuel injection equipment 10 is the addition air feeding device 15 with which atomizes and supplies a fuel only with the so-called air-current method, and the base 11 was equipped.

[Translation done.]

* NOTICES *

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the appearance perspective view of the fuel injection equipment concerning 1 operation gestalt of this invention.
[Drawing 2] It is the sectional view of the fuel injection equipment concerning 1 operation gestalt of this invention.
[Drawing 3] It is A-A cross-section view drawing in drawing 2 .
[Drawing 4] It is B-B cross-section view drawing in drawing 2 .
[Description of Notations]
10 Fuel Injection Equipment
11 Base
12 Injection Section
15 Addition Air Feeding Device
23 Air Advice Pipe
34 Opening
35 Building Envelope
36 Swirler
42 Body
43 Guide Bar
46 Nozzle

[Translation done.]

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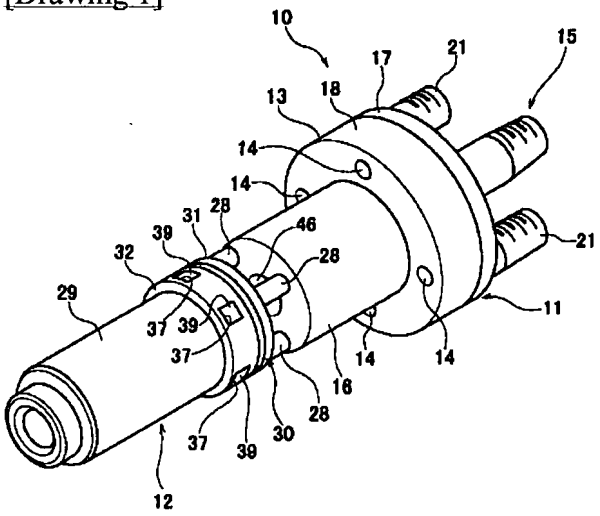
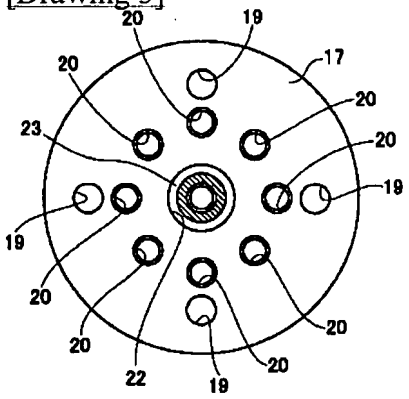
DRAWINGS

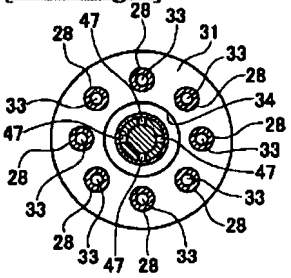
[Drawing 1]



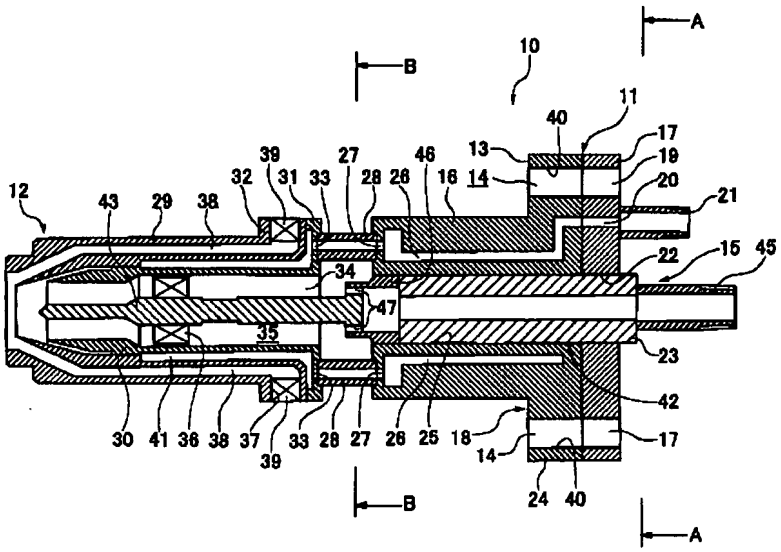
[Drawing 3]



[Drawing 4]



[Drawing 2]



[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2001－280155
（P2001－280155A）
(43)公開日　平成13年10月10日(2001.10.10)

(51)Int.Cl.[7]	識別記号	ＦＩ		テーマコード(参考)
Ｆ０２Ｃ 7/22		Ｆ０２Ｃ	7/22	Ｃ
7/26			7/26	Ｚ
Ｆ２３Ｒ 3/26		Ｆ２３Ｒ	3/26	Ｚ
3/28			3/28	Ｂ
3/30			3/30	

審査請求　未請求　請求項の数７　ＯＬ　（全７頁）

(21)出願番号　特願2000－94902(P2000－94902)
(22)出願日　平成12年３月30日(2000.3.30)

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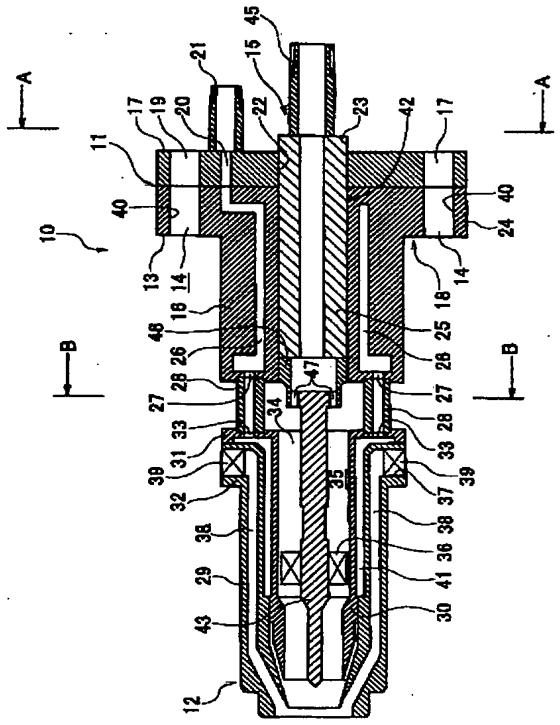
(54)【発明の名称】　ガスタービン用燃料噴射方法および装置

(57)【要約】
【課題】ガスタービンの着火～低負荷域においても少流量かつ高圧力の霧化燃料を供給できる燃料噴射装置を提供する。
【解決手段】着火～低負荷域においては、ポート４５から高圧の添加空気を導入する。この添加空気は、内部空間３５内を通って少流量の液体燃料を霧化する。機関回転数の上昇と共に添加空気の供給を停止し、定常運転を行う。



【特許請求の範囲】

【請求項１】　液体燃料を所定の燃料噴射方向の回りに旋回させて薄膜円環状に形成し、当該薄膜円環状に形成された燃料の内側および外側に上記燃料噴射方向の回りに旋回させた燃焼用空気を供給することによって当該液体燃料を微粒化してガスタービンの燃焼室に噴射供給するガスタービン用燃料噴射方法であって、

上記内側に供給される燃焼用空気と合流する添加空気を、ガスタービンの始動時にのみ送給することを特徴とするガスタービン用燃料噴射方法。

【請求項２】　請求項１記載のガスタービン用燃料噴射方法において、

上記添加空気の圧力は、０．２MPa～０．５MPa であることを特徴とするガスタービン用燃料噴射方法。

【請求項３】　液体燃料を所定の燃料噴射方向の回りに旋回させて薄膜円環状に形成し、当該薄膜円環状に形成された燃料の内側および外側に上記燃料噴射方向の回りに旋回させた燃焼用空気を供給することによって当該液体燃料を微粒化してガスタービンの燃焼室に噴射供給するガスタービン用燃料噴射装置であって、

上記内側に供給される燃焼用空気と合流する添加空気を送給するための添加空気送給手段を備えていることを特徴とするガスタービン用燃料噴射装置。

【請求項４】　請求項３記載のガスタービン用燃料噴射装置において、

上記添加空気を上記内側に供給される燃焼用空気と同方向に旋回させる空気旋回手段がさらに備えられていることを特徴とするガスタービン用燃料噴射装置。

【請求項５】　請求項３または４記載のガスタービン用燃料噴射装置において、

上記添加空気送給手段は、添加空気を上記内側に供給される燃焼用空気へ案内する案内ノズル部を備えていることを特徴とするガスタービン用燃料噴射装置。

【請求項６】　請求項５記載のガスタービン用燃料噴射装置において、

上記案内ノズル部は、上記内側に供給される燃焼用空気により形成される気流側へ突出されていることを特徴とするガスタービン用燃料噴射装置。

【請求項７】　請求項６記載のガスタービン用燃料噴射装置において、

上記案内ノズル部は、

添加空気の供給を受けるノズルと、

ノズルの先端部に設けられ、上記気流方向に延びる添加空気案内棒とを備えていることを特徴とするガスタービン用燃料噴射装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術の分野】この発明は、ガスタービンに使用される燃料噴射装置の改良に関するものである。

【０００２】

【従来の技術】ガスタービンを全域において良好に連続運転するためには、燃料を微粒化（霧化）すると共に運転域（負荷域）に応じた流量を確保して燃焼室に供給する必要がある。このため、燃料を燃焼室に供給するための燃料噴射装置が従来から種々提供されている。

【０００３】一般に燃料噴射方式としては、圧力噴霧方式（以下、「圧力方式」という。）と気流微粒化方式（以下、「気流方式」という。）とがある。圧力方式は、燃料を高圧状態にし、これをノズルから噴射することにより微粒化するものであり、燃料流量調整可能範囲が狭い。また、気流方式は、燃料に高速の空気（微粒化用空気）を接触させて微粒化するものであり、燃料流量調整可能範囲が広い。

【０００４】ガスタービンの始動時（着火～低回転域）においては、燃料は非常に少ない流量に設定する必要がある。このため、始動時においては圧力方式により少量の燃料を噴射供給するのが好ましい。一方、運転時（着火～全負荷域）では、各々の運転条件に応じた量の燃料（ターンダウン比が１：２０～４０）を供給する必要がある。

【０００５】ところが、圧力方式では、燃料圧力は流量（燃料供給量）の自乗に比例する関係にあるため、ターンダウン比をカバーしつつ燃料を霧化して供給するために高い圧力をかける必要がある。このため、全域で必要な燃料流量を確保しようとすると全負荷域において燃料をきわめて高圧にしなければならず、燃料噴射装置が強度確保のために大型化し、重量も重くなって実用的ではない。

【０００６】このため、従来では、無負荷～全負荷域においては気流方式のものが採用されている。つまり、従来の燃料噴射装置は、圧力方式のノズルと気流方式のノズルとの２つのタイプのノズルを併設することにより構成されている場合が多かった。

【０００７】

【発明が解決しようとする課題】しかしながら、かかる従来の燃料噴射装置では構造が複雑となり、重量が増加すると共に製造コストも上昇する。

【０００８】そこで、本発明の第１の目的は、一般に噴射圧力が低くても燃料の良好な微粒化を達成できる気流方式のみを採用し、全域において良好な燃料の供給を確保することができるガスタービン用燃料噴射方法を提供することである。

【０００９】また、本発明の第２の目的は、上記方法を使用するための安価で軽量なガスタービン用燃料噴射装置を提供することである。

【００１０】

【課題を解決するための手段】(1)　本発明の第１の目的を達成するため、本願に係る発明は、液体燃料を所定の燃料噴射方向の回りに旋回させて薄膜円環状に形成し、当該薄膜円環状に形成された燃料の内側および外側

に上記燃料噴射方向の回りに旋回させた燃焼用空気を供給することによって当該液体燃料を微粒化してガスタービンの燃焼室に噴射供給するガスタービン用燃料噴射方法であって、上記内側に供給される燃焼用空気と合流する添加空気を、ガスタービンの始動時にのみ送給することを特徴とするものである。

【００１１】この構成によれば、ガスタービンの無負荷時（始動時）には少流量（たとえば５CC／秒～２０CC／秒）の液体燃料を供給し、これを燃料供給方向に沿って旋回させて薄膜円環状に形成すると共に、添加空気送給手段により所要圧力（たとえば０．２MPa～０．５MPa）の添加空気を上記薄膜円環状に形成された燃料の内側に送給する。これにより、当該所要圧力の添加空気がガスタービンのコンプレッサにより吸気された燃焼用空気と合流し、燃料が上記圧力の下で霧化されて燃焼室へ送られる。

【００１２】ガスタービンが定常運転を開始すると、ガスタービンのコンプレッサによって多量の燃焼用空気が吸気され、上記薄膜円環状に形成された液体燃料を霧化するので、上記添加空気送給手段を停止させて添加空気の送給を停止する。なお、コンプレッサにより吸気された燃焼用空気は、上記薄膜円環状に形成された燃料の内側および外側に供給されるから、燃料の霧化を良好に行うことができる。

【００１３】特に、添加空気の圧力を０．２MPa～０．５MPa とすることによって、産業用ガスタービンを使用する場合に、工場等に設備されているエアツール用圧縮空気を添加空気として用いることができる。

【００１４】(2)　本発明の第２の目的を達成するため、本願に係る発明は、液体燃料を所定の燃料噴射方向の回りに旋回させて薄膜円環状に形成し、当該薄膜円環状に形成された燃料の内側および外側に上記燃料噴射方向の回りに旋回させた燃焼用空気を供給することによって当該液体燃料を微粒化してガスタービンの燃焼室に噴射供給するガスタービン用燃料噴射装置であって、上記内側に供給される燃焼用空気と合流する添加空気を送給するための添加空気送給手段を備えていることを特徴とするものである。

【００１５】この構成によれば、まずガスタービンの始動時には少流量（たとえば５CC／秒～２０CC／秒）の液体燃料を供給し、これを燃料供給方向に沿って旋回させて薄膜円環状に形成すると共に、添加空気送給手段により所要圧力（たとえば０．２MPa～０．５MPa ）の添加空気を上記薄膜円環状に形成された燃料の内側に送給する。これにより、当該所要圧力の添加空気ガスタービンのコンプレッサにより吸気された燃焼用空気と合流し、燃料が上記圧力の下で霧化されて燃焼室へ送られる。

【００１６】ガスタービンが定常運転を開始すると、ガスタービンのコンプレッサによって多量の燃焼用空気が吸気され、上記薄膜円環状に形成された液体燃料を霧化するので、上記添加空気送給手段を停止させて添加空気の送給を停止する。なお、コンプレッサにより吸気された燃焼用空気は、上記薄膜円環状に形成された燃料の内側および外側に供給されるから、燃料の霧化を良好に行うことができる。

【００１７】ここで、上記添加空気を上記円環状に形成された燃料の内側に供給される燃焼用空気（以下、適宜「内側空気」という。）と同方向に旋回させる空気旋回手段を設けることにより、燃料の霧化を一層良好なものとすることができる。

【００１８】また、上記添加空気送給手段に、添加空気を上記内側空気へ案内する案内ノズル部を設けることにより、添加空気を燃焼用空気に確実に合流させることができる。さらに、この案内ノズル部を、上記内側空気により形成される気流側へ突出させることにより、添加空気の合流をより確実なものとすることができる。

【００１９】さらに、上記案内ノズル部を、添加空気の供給を受けるノズルと、ノズルの先端部に設けられた添加空気案内棒とを備えて構成することにより、添加空気を案内棒に沿って確実に内側空気へ導くことができる。これにより、添加空気の燃焼用空気への合流をさらに確実なものとすることができる。

【００２０】

【発明の実施の形態】以下、本発明の実施の形態について説明する。

【００２１】図１は、本発明の一実施形態に係る燃料噴射装置の外観斜視図であり、図２は、燃料噴射装置の内部構造を示す断面図である。

【００２２】これらの図を参照して燃料噴射装置１０の概略について説明する。

【００２３】燃料噴射装置１０は、基部１１と噴射部１２とを備えており、基部１１にフランジ部１３が形成されている。この燃料噴射装置１０は、ガスタービンの燃焼室に設置され、噴射部１２から燃焼室内に燃料を噴射供給するものである。燃料噴射装置１０の取り付けは、噴射部１２をガスタービンの燃焼室内に挿入すると共に、フランジ部１３を燃焼室の入口周縁部に固定することにより行う。本実施形態では、締結ボルト挿通孔１４にボルトを挿通し、これを締め付けることにより、フランジ部１３と燃焼室の入口周縁部とが締結固定されるようになっている。

【００２４】本実施形態の特徴とするところは、燃料の供給方式にある。すなわち、この燃料噴射装置１０は、いわゆる気流方式によってのみ燃料を霧化して供給するものであり、基部１１に備えられた添加空気送給機構１５（添加空気送給手段）によって所定圧力の添加空気を、ガスタービン始動時に燃焼室に強制的に送る点がポイントである。これにより、ガスタービンの始動時から運転全域に対応した良好な燃料供給が可能であり、しか

も気流方式のみを採用することから燃料噴射装置１０の構造を簡単にでき、かつ燃料噴射装置１０を安価に提供することができるようになっている。以下、詳しく説明する。

【００２５】(1)　基部１１は、本体１６と、エンドプレート１７と、添加空気送給機構１５とを備えている。図３は、図２におけるＡ－Ａ断面矢視図である。図１～図３を参照して説明する。

【００２６】エンドプレート１７は、本体１６の後端面に取り付けられている。エンドプレート１７は、図３に示すように円盤状をしており、中心を基準として放射状に４つの貫通孔１９が設けられている。この貫通孔１９は、上述した締結ボルト挿通孔１４を構成している。また、エンドプレート１７の中心を基準として燃料供給孔２０が放射状に８つ設けられている。各燃料供給孔２０は、エンドプレート１７を貫通して形成されており、図２に示すように各燃料供給孔２０には燃料パイプ（図示せず）を接続するためのポート２１が突設されている。なお、本実施形態では、上記貫通孔１９を４つ、燃料供給孔２０を８つ設けたが、この数に限定されるものではないことは勿論である。また、エンドプレート１７の中央には、エンドプレート１７の中心を中心とする開口２２が貫通形成されている。この開口２２は、後述する添加空気送給機構１５の空気案内パイプ２３が挿通されるようになっている。

【００２７】図２を参照して、本体１６は円筒状に形成されており、その後端部に鍔部２４が形成されている。この鍔部２４は、上述したフランジ部１３を構成している。鍔部２４には、貫通孔４０が４つ形成されている。これら貫通孔４０と上記エンドプレート１７の貫通孔１９とは同径に設定されており、各孔の中心が一致するようになっている。よって、鍔部２４に設けた貫通孔と上記貫通孔１９とにより、上述した締結ボルト挿通孔１４が構成されている。

【００２８】本体１６の中心には、本体１６の長手方向に沿って貫通孔２５が形成されている。この貫通孔２５は、上記エンドプレート１７の開口２２と同径に設定されており、エンドプレート１７を本体１６に取り付けた状態で、貫通孔２５と開口２２とがぴったりと一致するようになっている。そして、この貫通孔２５と開口２２とにより添加空気送給機構１５を支持する支持部が構成されており、添加空気送給機構１５は、基部１１によって後述のようにして支持されている。

【００２９】また、本体１６の後端面には、エンドプレート１７の燃料供給孔２０に対応して８つの燃料案内孔２６が形成されている。つまり、本体１６にエンドプレート１７を取り付けた状態で、燃料供給孔２０と燃料案内孔２６とがぴったりと一致し、ポート２１に供給された燃料は、本体１６の内部を先端側へ案内されるようになっている。各燃料案内孔２６は、本体１６の先端面まで貫通しており、本体１６の先端面にはこれに対応する開口２７が８つ形成されている。なお、各開口２７にはパイプ部材２８が固定されており、開口２７に案内された燃料は、このパイプ部材２８を通って噴射部１２側へさらに案内されるようになってる。

【００３０】(2)　次に、噴射部１２は、図１に示すように全体として円筒状に形成されており、外筒部２９と内筒部３０とを備えている（図２参照）。図４は、図２におけるＢ－Ｂ断面図である。図２および図４を参照して説明する。

【００３１】内筒部３０は、基端部に鍔３１が形成されたパイプ状の部材である。一方、外筒部２９も基端部に鍔３２が形成されたパイプ状の部材である。そして、内筒部３０は、外筒部２９の基端部側から挿入して、鍔３１を鍔３２に当接させた状態で内筒部３０が外筒部２９に取り付けられている。内筒部３０の鍔３１には貫通孔３３が８つ形成されている。各貫通孔３３には、上記パイプ部材２８が接続されている。これにより、パイプ部材２８へ供給案内された燃料は、さらに噴射部１２側へ送られるようになっている。

【００３２】内筒部３０の鍔３１の中央には開口３４が形成されており、この開口３４に連通して内筒部２９の内側に内部空間３５が形成されている。この開口３４は、燃料の燃焼用空気の取入口として機能し、取り入れられた空気は、内部空間３５に沿って送られる。そして、後述のように内部空間３５にはスワーラ３６（空気旋回手段）が配設されている。このように、内部空間３５によって、取り入れられた燃焼用空気が気流を形成するようになっている。

【００３３】外筒部２９は、さらに二重構造の筒状に形成されている。図１および図２を参照してさらに詳述すると、鍔３２の周囲には、複数個の吸気口３７が形成されており、各吸気口３７に連続して吸気路３８が形成されている。この吸気路３８は、外筒部２９の内部において筒状に形成されている。各吸気口３７にはスワーラ３９が設けられており、この吸気口３７から吸気される空気は、スワーラ３９によって外筒部２９の長手方向の回りに旋回する旋回流となり、この旋回流が上記吸気路３８に沿って流れる。なお、各吸気孔３７から取り入れられた空気は、上記開口３４から取り入れられる空気と同様に燃料の燃焼用に費やされる（すなわち燃焼用空気として使用される）。

【００３４】内筒部３０を外筒部２９に挿入した状態では、図２に示すように両者間に隙間４１が形成される。この隙間４１は円環状に形成されることになり、各パイプ部材２８と連通している。したがって、パイプ部材２８によって供給案内された燃料は、この隙間４１に進入し、隙間４１を通って噴射部１２の先端側へ送られるようになっている。ここで、隙間４１の先端側は、軸方向に沿って螺旋状に形成されている。これにより、先端側

へ送られた燃料は、その軸方向回りに旋回され、薄肉円環状に形成されることになる。

【００３５】したがって、上記薄膜円環状に形成された燃料の内側および外側に、上記燃焼用空気が送られるようになっている。

【００３６】(3)　次に、図１および図２を参照して添加空気送給機構１５について説明する。

【００３７】添加空気送給機構１５は、本体４２と、案内棒４３（添加空気案内棒）とを備えている。

【００３８】本体４２は、上述した空気案内パイプ２３と、空気案内パイプ２３の後端に接続されたポート４５と、空気案内パイプ２３の先端に設けられたノズル４６とを有している。

【００３９】空気案内パイプ２３は、エンドプレート１７の開口２２および本体１６の貫通口２５により形成される収容空間内に嵌め込まれている。また、ポート４５は、添加空気を外部から取り入れる部分であって、たとえば工場等においてはエアツール用圧縮空気が供給されるようになっている。

【００４０】ノズル４６は、図２に示すように、先端側が縮径されたいわゆる段付きパイプ状に形成されている。ノズル４６の後端側は、上記収容空間内にぴったりと挿入されており、かつ後端面が空気案内パイプ２３の先端面と当接固着されている。また、ノズル４６の縮径された先端部は、噴射部１２の内筒部３０の開口３４側、すなわち、開口３４から内部空間３５に送られる上記燃焼用空気によって形成される気流側へ突出されている。このようにノズル４６の先端部が突出されていることによる作用効果については後述する。

【００４１】図４は、図２におけるＢ－Ｂ断面矢視図である。図２および図４を参照して、案内棒４３は、断面が円形の細長棒により形成されている。案内棒４３の後端部は円形の鍔状に形成されており、この部分がノズル４６の先端側にぴったりと嵌め込まれている。案内棒４３は、内筒部３０の中に略同軸状に挿入されており、その先端部は、噴射部１２の先端近傍まで延びている。これにより、内部空間３５内の空気は、この案内棒４３に沿うようにして良好に送給されるようになっている。

【００４２】図４に示すように、案内棒４３の後端部には軸方向に貫通する孔４７が形成されている。本実施形態では、この孔４７は４つ設けれられているが、この数に限定されることはなく、ノズル４６から上記内部空間３５に添加空気を送ることができるように孔４７が形成されていればよい。

【００４３】また、案内棒４３の中間部に上述したスワーラ３６（空気旋回手段）が設けられている。このスワーラ３６は、開口３４から取り入れられた燃焼用空気を内筒部３０の長手方向の回りに右または左回りに旋回させるためのものである。内部空間３５に導かれた添加空気は、開口３４から取り入れられた燃焼用空気と共にスワーラ３６よって旋回され、先端側へ送られるようになっている。

【００４４】(4)　次に、本実施形態に係る燃料噴射装置１０の動作について作用効果と共に説明する。

【００４５】図１および図２を参照して、この燃料噴射装置１０では、燃料（液体燃料）はポート２１から燃料案内孔２６を通ってパイプ部材２８を介して噴射部１２側へ送られる。噴射部１２側へ送られた燃料は、隙間４１を通って薄膜円環状に形成される。一方、燃料と同時に吸気口３７および開口３４から空気（燃焼用空気）が取り入れられ、吸気口３７から取り入れた空気が所定方向に旋回されると共に開口３４から取り入れた空気が反所定方向に旋回される。これにより、薄膜円環状に形成された燃料の内側および外側には、それぞれ互いに反対方向に旋回する燃焼用空気が送られ、両者の気流によって燃料が霧化される。つまり、本実施形態に係る燃料噴射装置１０は、気流方式のみを採用するものである。

【００４６】ところで、この燃料噴射装置１０が使用されるガスタービンは、無負荷時（始動時）には供給する燃料を少量（たとえば５CC／秒～２０CC／秒）に抑える必要がある。ところが、気流方式により燃料を供給する場合には、少量の燃料を良好に霧化することができない。なぜなら、無負荷時～低負荷域では機関回転数が低く、十分な量の燃焼用空気を取り込むことができないからである。

【００４７】しかし、本実施形態では、かかる着火～低負荷域において添加空気送給機構１５によって添加空気を導入することができる。この添加空気は、ポート４５から空気案内パイプ２３を通ってノズル４６から噴射部１２の案内空間３５内に導入される。この添加空気はエアツール用圧縮空気を使用することができ、その圧力としては０．２MPa～０．５MPa 程度のものを採用することができる。

【００４８】この高圧の添加空気は、内部空間３５を通って上記薄膜円環状に形成された燃料の内側に送給される。これにより、高圧の添加空気が上記燃焼用空気と合流し、燃料が上記圧力の下で霧化されて燃焼室へ送られる。

【００４９】その後、ガスタービンが定常運転を開始すると、ガスタービンのコンプレッサによって多量の燃焼用空気が送られ、燃料を良好に霧化するので、添加空気送給機構１５を停止させて添加空気の送給を停止する。なお、コンプレッサにより送られた空気は、上述のように薄膜円環状に形成された燃料の内側および外側に供給されるから、燃料の霧化を良好に行うことができる。

【００５０】特に本実施形態では、スワーラ３６が設けられており、上記添加空気を、上記燃料の内側に供給される燃焼用空気と同方向に旋回させることができる。これにより、当該内側空気の旋回気流の勢いが増し、燃料の霧化を一層良好なものとすることができるという利点

がある。

【００５１】また、添加空気を送給するためにノズル４６を設けているから、添加空気を確実に燃焼用空気と合流させることができる。しかも、このノズル４６を開口３４側へ突出させているので、添加空気を内部空間３５内で形成される気流と一層確実に合流させることができる。これにより、燃料の霧化をなお一層良好なものとすることができる。

【００５２】このように、本実施形態では、ガスタービンの始動時にのみ高圧の添加空気を送給するという方式を採用しているから、始動時に必要な圧力の微小燃料を霧化して確実に始動することができる。しかも、始動後の運転域では通常の気流方式により燃料の供給を行うことができる。よって、ガスタービンの運転全域において、気流方式のみによる適正な燃料供給を行って良好な連続運転が実現できると共に、燃料噴射装置１０の構造を簡単にして安価なものとすることができる。

【００５３】

【発明の効果】以上のように本願に係る発明によれば、次のような効果を奏する。ガスタービンの始動時（点火時）は無負荷域であるから、供給すべき燃料流量は微量でなくてはならない。他方、始動時において供給燃料の圧力が低いと始動（点火）することができない。しかし、本発明では、始動時に添加空気を供給することにより始動に必要な圧力の微小燃料を供給することができるので、確実に始動することができる。しかも、始動後の運転域では、添加空気の供給を停止することにより、通＊常の気流方式により燃料の供給を行うことができる。

【００５４】このように、本発明では、ガスタービンの運転全域において、気流方式による適正な燃料供給を行って良好な連続運転を可能とするものであり、しかも、従来のような圧力方式と気流方式とを併用するものではないので、構造が簡単で安価なものとすることができる。

【図面の簡単な説明】

【図１】本発明の一実施形態に係る燃料噴射装置の外観斜視図である。

【図２】本発明の一実施形態に係る燃料噴射装置の断面図である。

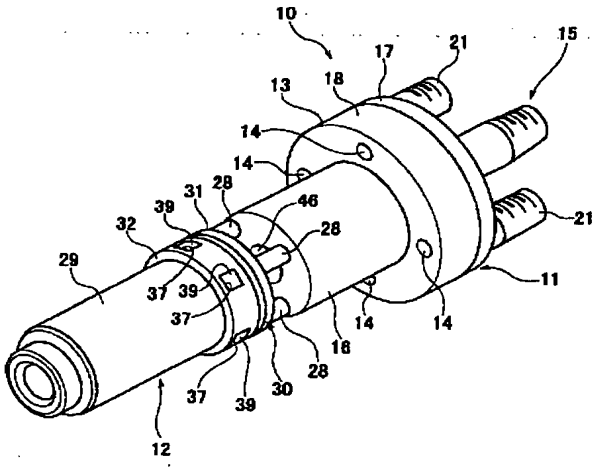
【図３】図２におけるＡ－Ａ断面矢視図である。

【図４】図２におけるＢ－Ｂ断面矢視図である。

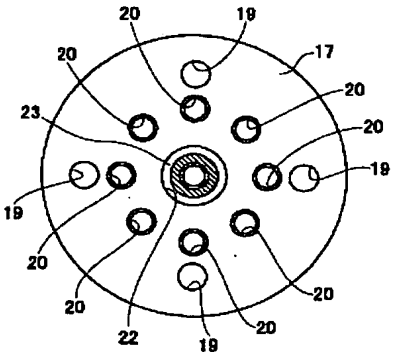
【符号の説明】

１０　燃料噴射装置
１１　基部
１２　噴射部
１５　添加空気送給機構
２３　空気案内パイプ
３４　開口
３５　内部空間
３６　スワーラ
４２　本体
４３　案内棒
４６　ノズル

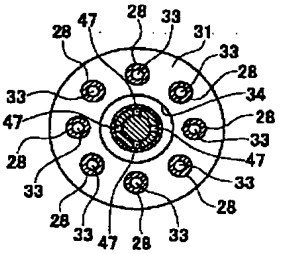
【図１】



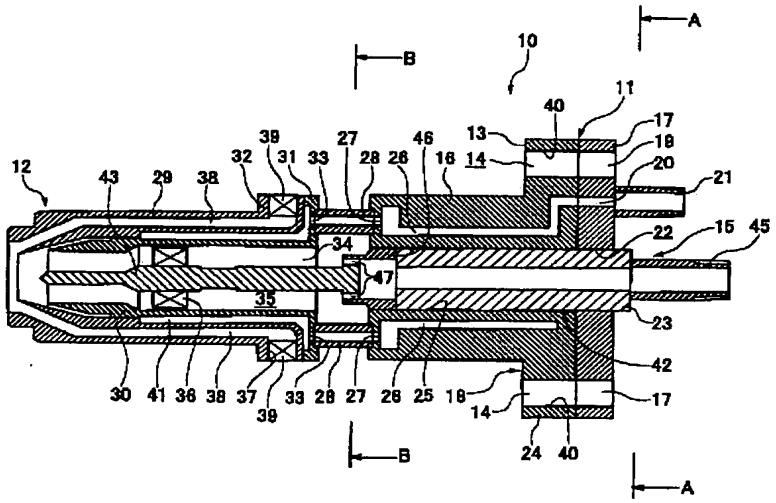
【図３】



【図４】



【図２】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